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A Collection of Early Swiss Meteorological Series

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Abstract

Within the framework of the Swiss National Science Foundation project "Swiss Early Instrumental Meteorological Data" (CHIMES) and the project "Long Swiss Meteorological Series" (funded by the Global Climate Observing System (GCOS) Switzerland), early instrumental meteorological records from Switzerland were systematically searched, collected, imaged, and digitised. This volume compiles short papers, each of which describes a series. The volume accompanies the publication of the imaged sources and of the digitised observations. In this introductory paper we provide an overview of the project and of the series comprised in this volume.

1. Introduction

The increasing rate of warming and the awareness of the immediacy and reality of climate change generate a need for meteorological data for adaptation and climate risk management. Changes need to be assessed in the context of long time series and impact models need to be tested for observed events. As a consequence, past weather data become once again an important resource. It is no longer just the mean climate (for which reconstructions are available) that is of interest, but extremes and variability on weather time scales as well as information on a regional level. New numerical techniques such as data assimilation are able to use historical observations to produce comprehensive day-to-day weather reconstructions (Compo et al., 2011) from which further products can be derived, thus catering the needs of climate impact research. Other methods can also be used to obtain daily weather information such as

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weather types (Schwander et al., 2017; Delaygue et al., 2019) or analog approaches (Flückiger et al., 2017; Pfister et al., 2019b).

Many studies have demonstrated that historical weather observations can be used for climate risk assessments (Pfister, 1999; Jacobeit et al., 2003; Glaser and Stangl, 2004; Rohr, 2013). For instance, model chains can be built (Brönnimann et al., 2019b), starting from global reanalyses and dynamical downscaling to the use of specific climate impact models. These model chains can make use of other environmental and societal data (Pfister et al., 2017), thus allowing a much more comprehensive study of past weather and climate events.

However, vast amounts of historical weather data have still not been digitised, including in Switzerland. The Swiss Meteorological Network was initiated in December 1863 and maintained by the Swiss Natural Sciences Society and later MeteoSwiss (Hupfer, 2019). Three prominent Swiss series that reach further back than 1864, namely Geneva, Basel, Gr. St. Bernard, and that have been evaluated in the 1950s and 1960s (Bider et al., 1959; Bider and Schüepp, 1961; Schüepp, 1961) have recently been digitised based on the original readings (Füllemann et al., 2011). However, Swiss archives hold many more data records. Information on the Swiss measurements before 1864 has been compiled in the late 19th and early 20th century (*e.g.,* Billwiller, 1927), but the data have never been published. Some authors (Gisler, 1984; Burri and Zenhäusern, 2009) have used monthly data for some of the series, but the original data have so far not been digitised. However, the climate of the late 18th and 19th centuries might hold the key for better understanding decadal climate processes as this period encompassed a pronounced warm phase around 1800 (Frank et al., 2007) or the cold period in the early 19th century (Brönnimann et al., 2019c).

In the framework of the Swiss National Science Foundation project "Swiss Early Instrumental Meteorological Data" (CHIMES), we have systematically compiled early instrumental meteorological series from Switzerland. Over 300 series could be found prior to 1864. A large number of them is from a network in the Grisons dating to the 1850s (Hupfer, 2015), but there are also many earlier series, the earliest dating back to the year 1708 (Boscani Leoni, 2018). The full inventory was published by Pfister et al. (2019a). For many of the series, the data could be found, and a large fraction of the series found was imaged. These images are available publicly at: https://zenodo.org/record/3066836#.XVv-fGRS8-U. A large fraction of the imaged series was then digitised. However, a much larger amount of series was found than anticipated. Further digitising of long records is now performed in the framework of the project "Long Swiss Meteorological Series", which is funded by the Global Climate Observing System (GCOS) Switzerland. The digitised data from the CHIMES project are described in a dedicated scientific paper (Brugnara et al., 2019). They are available from the repositories PANGAEA (https://doi.pangaea.de/10.1594/PANGAEA.909141), MeteoSwiss, and EURO-CLIMHIST (Pfister et al., 2017; www.euroclimhist.unibe.ch) and will be integrated into the Global Land and Marine Observations Database built under the framework of Copernicus Climate Change Service (C3S) (Thorne et al., 2017).

This volume complements the publication of the data by providing important metadata on the series. The metadata comprises information on the stations, observers, instruments, on the original formats or the scientific context in which they were taken. We also show the data series and summarise results of the quality control for each series, which cannot be undertaken in an overview publication.

The paper is organised as follows. Section 2 briefly describes the inventory. In Section 3 we introduce the papers that are compiled in this first part of the volume – more papers will follow in the near future as digitisation of the data proceeds. Section 4 provides a summary and conclusion of the paper and provides an outlook to future work.

2. Summary of the inventory

The project started with compiling literature and earlier overviews as well as with numerous archive visits. This process resulted in an inventory, which has been published by Pfister et al. (2019a). It contains 334 entries from 206 locations, which encompass ca. 3640 station years. Figure 1 provides an overview of the series inventoried. Urban centres such as Geneva, Bern, Zurich and Basel stand out, but also smaller towns (Aarau, Delémont, Frauenfeld, Schaffhausen) may have long records. We also find important records from monasteries and hospices (Gr. St. Bernard, St. Gotthard, Einsiedeln), in rural settings (network of the Bernese Economic Society in the 1760s), or in early tourist locations (Grisons in the 1850s). The spatio-temporal distribution of the data reflects the history of Swiss climate observations (see Pfister et al., 2019a; Hupfer, 2019) and the contemporary political, economic, technical and scientific context. Such context information is important for understanding and better interpreting climate data (Brönnimann and Wintzer, 2019).

The first observers were members of the scholarly communities of the Enlightenment. As elsewhere in Europe, observational programmes by scientific societies were started and the scope was widened. Observers in these networks were not always professional scientists, but often also members of the clergy or amateurs. The first network in Switzerland was established by the Bernese Economic Society in 1760 (Pfister, 1984). As all other networks of this

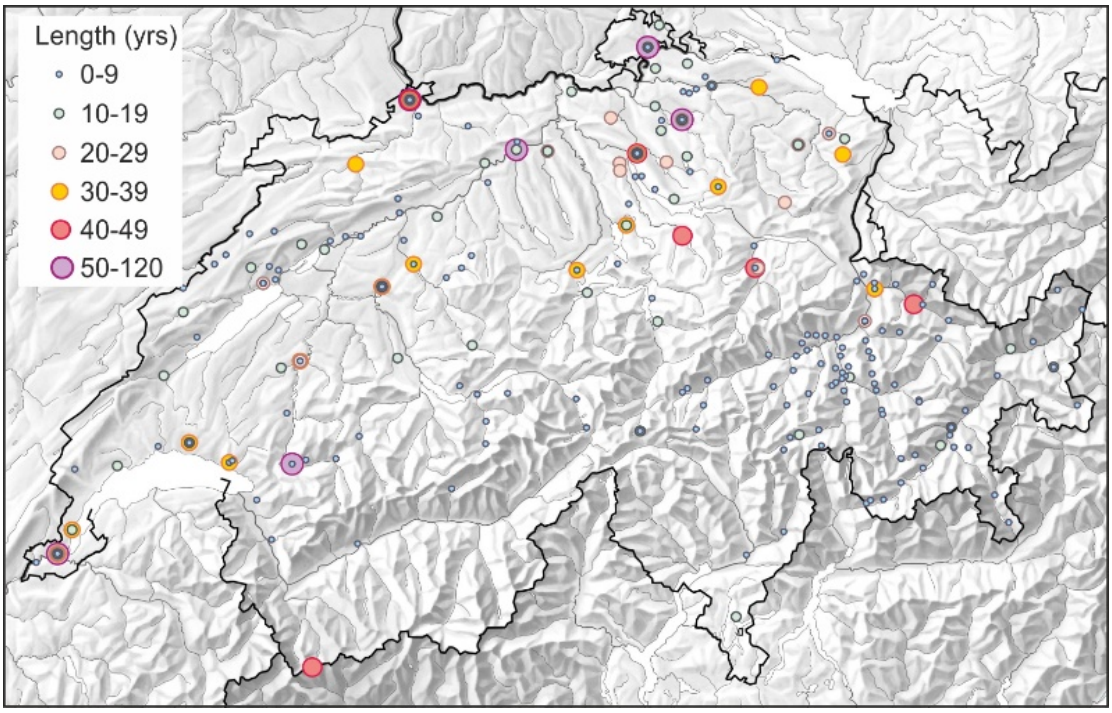

Figure 1. Location and length (prior to 1864) of the records compiled in the inventory (from Pfister et al., 2019a).

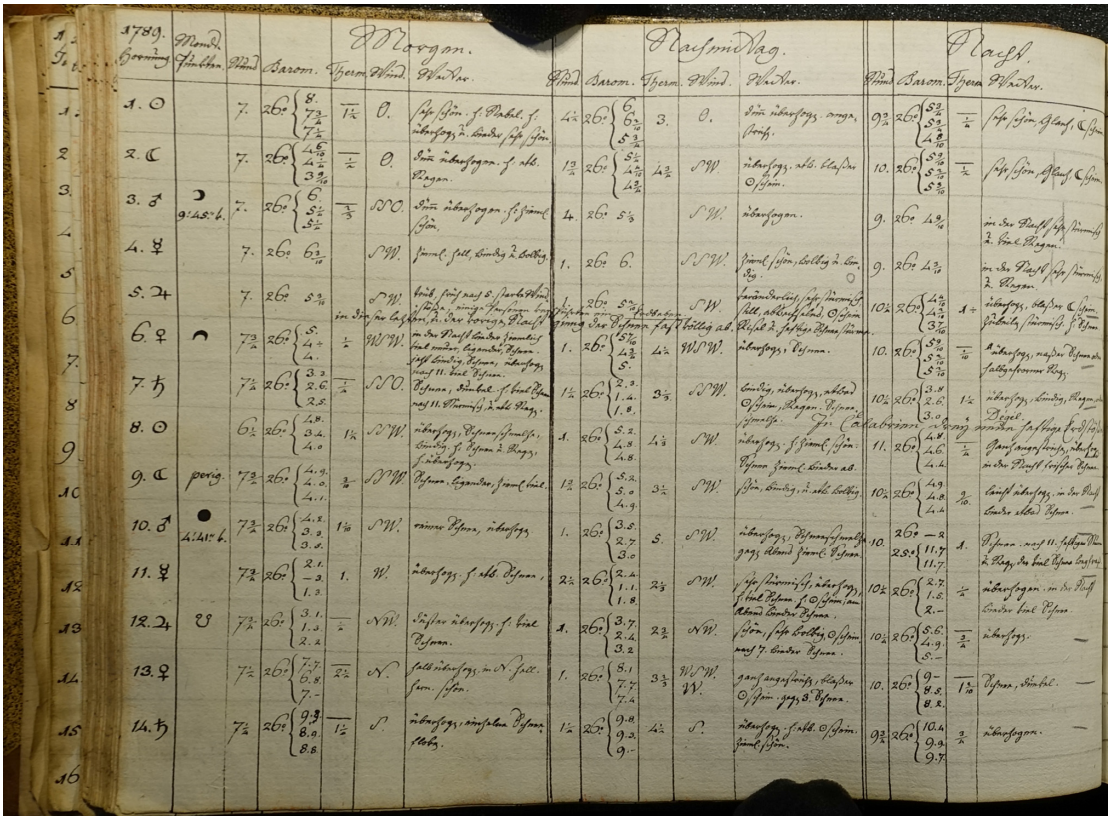

Figure 2. Data sheet with meteorological measurements form Bern by Samuel Studer, 1789 (Burgerbibliothek Bern: Mss.h.h.XX.5.2, photo: Lucas Pfister).

time, it could not be sustained. In the early 19th century, many of the Cantonal Natural Sciences Societies tried to establish networks, such as the societies in Aarau, Thurgau, Bern, and Neuchâtel. Also the Swiss Society of Natural Sciences had corresponding plans (see Pfister et al., 2019a; Hupfer, 2019). Other networks such as that in the Grisons as well as many individual series also grew out of private initiative (Hupfer, 2015).

Based on the inventory, daily weather reconstruction for Switzerland should be possible back to around the 1760s. At least 15 records should be available at any time from then onwards. Note that Schwander et al. (2017) have reconstructed Swiss weather types back to 1763 using (for the first 100 years) only stations from neighbouring countries. Flückiger et al. (2017) have reconstructed daily fields for 1815–1817 using an analog approach based on three stations (two in Switzerland). The instrumental information could be further complemented with observations from weather diaries, which we did not systematically compile.

The series were searched electronically in various online libraries and online resources, and were physically searched in numerous archives (including the Swiss Federal Archives, Cantonal Archive Aargau, Cantonal Library Aargau, University Library Basel, Burgerbibliothek Bern, University Library Bern, Archive of the Monastery of Einsiedeln, Cantonal/University Library Fribourg, Cantonal Archive and Library Geneva, Cantonal Library/Archive Grisons, University Library Neuchâtel, City Archive Schaffhausen, Cantonal Library Vadiana St. Gall, Cantonal Archive Vaud, Cantonal/University Library Lausanne, Cantonal Archive Zurich, City Library Zurich). During these visits, the data sheets and metadata for the series found were photographed whenever possible.

The raw material imaged in numerous archives is often in handwritten form. Figure 2 shows an example of a data sheet from Bern from the year 1789 in a beautiful handwriting. Some handwritings were, however, much more difficult to read. Deciphering these sources often requires trained historians. In contrast, some other sources were readily accessible in printed format, and digitising was much easier. For further information on the process of rescuing data, the reader is referred to Wilkinson et al. (2019).

The images themselves are an important source of information, since digitising efforts were largely restricted to instrumental variables (Brugnara et al., 2019). Wind direction was mostly digitised, sometimes rainfall or cloud cover. However, weather descriptions were not transcribed, but can be found on the images published. Pfister et al. (2019a) provide examples for the additional information that can be gained from such non-instrumental information.

3. Papers in this volume

The papers in this first part of the volume cover a number of series from five different locations. The paper by Häderli et al. (2020) compares early series from Geneva from the 1780s and 1790s, when two observers took measurements in Geneva. Brönnimann et al. (2020) cover the various segments of the Geneva series from 1798 to the start of the MeteoSwiss network in 1863. The papers contribute to enhancing this long and famous series from Geneva, which will be further complemented backwards with additional series in the framework of the GCOS Switzerland project "Long Swiss Meteorological Series".

A long series from Aarau, covering five decades from 1807 to the start of the MeteoSwiss network is descried in the paper by Faden et al. (2020). Merged with the station data from MeteoSwiss after 1864, this will provide another more than 200 year long series. The paper by Weber et al. (2020) deals with two series from Herisau, in the eastern part of Switzerland, 1821–1844. Hürzeler et al. (2020) describe another potential 200-yr record, namely from St. Gall. Their paper covers the years 1812–1853. With a gap of several years (measurements are also available for 1857/8 and from 1864 onwards), another 200-year record could be produced. The last paper (Flückiger et al., 2020) examines two series from Bern, together covering the period 1826–1853 (see also Flückiger, 2018). Again there is a 12-yr overlap that allows a comparison of the series. Many additional series are available from Bern such that, though with two or three gaps of several years, a series could be constructed that reaches back to 1760 and thus would constitute one of the longest series in Switzerland.

The series from Marschlins from the late 18th century is described by Grimmer (2019) in a Master thesis written in English and accessible online through a permanent repository. Consequently, there is no article about this series in this collection. The series from Marschlins can also be extended to a new long Swiss meteorological series.

Future papers in this volume will concern the long record of Zurich. Here, the first instrumental measurements in Switzerland were performed by Scheuchzer in 1708 (Boscani Leoni, 2018), although only available as excerpts. Relatively complete data are available from 1718 to 1730 and then from the 1750s onwards. The corresponding papers, similar as those for the numerous series of Basel (reaching back to 1755), some remaining series from Bern, the long series from Schaffhausen (back to 1790), Einsiedeln, Gr. St. Bernhard and others will be published in a second part of this volume. In total, when complemented with MeteoSwiss

data after 1864, we expect 10 long Swiss series of more than 200 years length plus numerous shorter series or series with longer gaps.

The papers in this volume are all structured similarly. Each paper starts with a biography of the observer and a description of the exact location, details on observations and instruments, as well as on other relevant context. Each paper also shows examples of how the data were available to us (images of the data forms). The papers then also present the digitised data and describe their quality using a standard set of plots. This common structure should facilitate the comparison across the papers.

Many of the instruments are the same or similar for several of the series, and the process of converting and adjusting the data or of reducing pressure is the same for all papers (see also Brugnara et al., 2019). We therefore begin this volume with a paper (Brugnara et al., 2020) that describes the instruments, scales, potential quality issues as well as all further processing of the data (see also Brugnara et al., 2015). The paper also deals with the quality control procedure and the standard plots that are then found in the individual papers.

4. Conclusions and outlook

This volume describes a number of early instrumental meteorological series from Switzerland that were acquired within the framework of the Swiss National Science Foundation project "Swiss Early Instrumental Meteorological Data" (CHIMES) and the project "Long Swiss Meteorological Series" (funded by the Global Climate Observing System (GCOS) Switzerland). The images series as well as the final data are made available in public repositories, accompanied by papers in the scientific literature. The inventory of this project is also published (Pfister et al., 2019a) and is included in a global inventory of early instrumental meteorological observations (Brönnimann et al., 2019d). This volume does not duplicate the work, but provides much more detailed information on specific series. It is important to preserve this information, which was painfully compiled during the project, for posteriority as scientists in the future may revert back to this material to extract other information.

Each of the following papers provides the meta-information for one series. Many of the papers are the outcome of student works (Bachelor or Master theses). Digitising was done by several student assistants and assistants. Subsequently, the data were quality controlled (QC) (Brugnara et al., 2019, 2020) using software developed in the framework of the Copernicus Climate Change Service project 311a Lot 1 (Brönnimann et al., 2019a; Brunet et al. 2020). The data were eventually converted to a standard format, published at the repository PANGAEA (https://doi.pangaea.de/10.1594/PANGAEA.909141), MeteoSwiss, and EURO-CLIMHIST and they will be incorporated into the C3S Global Land and Marine Observations Database (Thorne et al., 2017). In this way, our project contributes to the Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative (Allan et al., 2011).

Our inventory as well as this volume does not (or at least not systematically) cover non-instrumental information (see Brugnara et al., 2019). However, observations such as wind direction, precipitation, or clouds could contribute to useful information to daily weather reconstructions. In fact, for Geneva this was demonstrated by Auchmann et al. (2012). Such information is available from EURO-CLIMHIST and might in the future be compiled in a more systematic way.

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References

Allan, R., P. Brohan, G. P. Compo, R. Stone, J. Luterbacher, and S. Brönnimann (2011) The International Atmospheric Circulation Reconstructions over the Earth (ACRE) Initiative. *Bull. Amer. Meteorol. Soc.,* **92.** 1421–1425.

Auchmann, R., Brönnimann, S., Bred, L., Bühler, M., Spadin, R., and Stickler, A. (2012) Extreme climate, not extreme weather. the summer of 1816 in Geneva, Switzerland. *Clim. Past,* **8,** 325–335.

Bider, M. and M. Schüepp (1961) Luftdruckreihen der letzten zwei Jahrhunderte von Basel und Genf. *Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie B,* **11,** 1–36.

Bider, M., M. Schüepp, and H. von Rudloff (1959) Die Reduktion der 200jährigen Basler Temperaturreihe. *Arch. Met. Bioklim.* **B9**, 360–411

Billwiller, R. (1927) *Klimatologie: Mit einem Anhang: Erdmagnetismus, von Dir. Dr. J. Maurer, Zürich.* Bibliographie der schweizerischen Landeskunde, IV4, K. J. Wyss Erben, Bern.

Boscani Leoni, S. (2018) Zwischen London und den Alpen. Johann Jakob Scheuchzer (1672–1733) und die ersten meteorologischen Messungen in der Schweiz. *GeoAgenda*, **2018/3,** 4–7.

Brönnimann, S. and J. Wintzer (2019) Climate Data Empathy. *WIREs Climate Change,* **10,** e559.

Brönnimann, S., Y. Brugnara, R. J. Allan, P. Brohan, M. Brunet, G. P. Compo, R. I. Crouthamel, P. D. Jones, S. Jourdain, J. Luterbacher, P. Siegmund, M. A. Valente, and C. W. Wilkinson (2019a) A roadmap to climate data rescue services. *Geoscience Data Journal*, **5,** 28–39.

Brönnimann, S., O. Martius, C. Rohr, D. N. Bresch, and K.-H. E. Lin (2019b) Historical Weather Data for Climate Risk Assessment. *Annals of the New York Academy of Sciences*, **1436,** 121–137.

Brönnimann, S., J. Franke, S. U. Nussbaumer, H. J. Zumbühl, D. Steiner, M. Trachsel, G. C. Hegerl, A. Schurer, M. Worni, A. Malik, J. Flückiger, and C. C. Raible (2019c) Last phase of the Little Ice Age forced by volcanic eruptions. *Nature Geoscience,* **12,** 650–656.

Brönnimann, S., R. Allan, L. Ashcroft, S. Baer, M. Barriendos, R. Brázdil, Y. Brugnara, M. Brunet, M. Brunetti, B. Chimani, R. Cornes, F. Domínguez-Castro, J. Filipiak, D. Founda, R. García Herrera, J. Gergis, S. Grab, L. Hannak, H. Huhtamaa, K. S. Jacobsen, P. Jones, S. Jourdain, A. Kiss, K. E. Lin, A. Lorrey, E. Lundstad, J. Luterbacher, F. Mauelshagen, M. Maugeri, N. Maughan, A. Moberg, R. Neukom, S. Nicholson, S. Noone, Ø. Nordli, K. B. Ólafsdóttir, P. R. Pearce, L. Pfister, K. Pribyl, R. Przybylak, C. Pudmenzky, D. Rasol, D. Reichenbach, L. Řezníčková, F. S. Rodrigo, R. Rohde, C. Rohr, O. Skrynyk, V. Slonosky, P. Thorne, M. A. Valente, J. M. Vaquero, N. E. Westcottt, F. Williamson, P. Wyszyński (2019d) Unlocking pre-1850 instrumental meteorological records: A global inventory. *Bull. Amer. Meteorol. Soc.,* **100,** ES389–ES413.

Brönnimann, S., M. Bühler, and Y. Brugnara (2020) The series from Geneva, 1798–1863. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 47–59, doi: 10.4480/GB2020.G96.04.

Brugnara, Y., R. Auchmann, S. Brönnimann, R. J. Allan, I. Auer, M. Barriendos, H. Bergström, J. Bhend, R. Brázdil, G. P. Compo, R. C. Cornes, F. Dominguez-Castro, A. F. V. van Engelen, J. Filipiak, J. Holopainen, S. Jourdain, M. Kunz, J. Luterbacher, M. Maugeri, L. Mercalli, A. Moberg, C. J. Mock, G. Pichard, L. Řezníčková, G. van der Schrier, V. Slonosky, Z. Ustrnul, M. A. Valente, A. Wypych, and X. Yin (2015) A collection of sub-daily pressure and temperature observations for the early instrumental period with a focus on the "year without a summer" 1816. *Clim. Past* **11,** 1027–1047.

Brugnara, Y., L. Pfister, L. Villiger, C. Rohr, F. A. Isotta, and S. Brönnimann (2019) Early instrumental meteorological observations in Switzerland: 1708–1873. *Earth Syst. Sci. Data Disc.,* doi: 10.5194/essd-2019-234.

Brugnara, Y., J. Flückiger, and S. Brönnimann (2020) Instruments, procedures, processing, and analyses. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 17–32, doi: 10.4480/GB2020.G96.02.

Brunet, M., Y. Brugnara, S. Noone, A. Stephens, M. A. Valente, C. Ventura, P. Jones, A. Gilabert, S. Brönnimann, J. Luterbacher, R. Allan, P. Brohan, and G. P. Compo (2020) *Best Practice Guidelines for Climate Data and Metadata Formatting, Quality Control and Submission.* Copernicus Climate Change Service (in preparation).

Burri, M. and G. Zenhäusern (2009) Sommertemperaturen im Spiegel von Ernte– und Schneebeobachtungen aus Bern und Wallis 1766–1812. *Blätter aus der Walliser Geschichte* **41**, 189–206.

Compo, G. P., J. S. Whitaker, P. D. Sardeshmukh, N. Matsui, R. J. Allan, X. Yin, B. E. Gleason, R. S. Vose, G. Rutledge, P. Bessemoulin, S. Brönnimann, M. Brunet, R. I. Crouthamel, A. N. Grant, P. Y. Groisman, P. D. Jones, M. Kruk, A. C. Kruger, G. J. Marshall, M. Maugeri, H. Y. Mok, Ø. Nordli, T. F. Ross, R. M. Trigo, X.

Wang, S. D. Woodruff, and S. J. Worley (2011) The Twentieth Century Reanalysis Project. *Q. J. R. Meteorol. Soc.,* **137,** 1–28.

Delaygue, G., S. Brönnimann, P. Jones, J. Blanchet, and M. Schwander (2019) Reconstruction of Lamb weather type series back to the 18th century. *Clim. Dyn.,* **52,** 6131–6148.

Faden, M., L. Villiger, Y. Brugnara, and S. Brönnimann (2020) The meteorological series from Aarau, 1807–1865. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 61–72, doi: 10.4480/GB2020.G96.05.

Flückiger, J. (2018) *Glacier-friendly weather? Sub-daily pressure and temperature data from the city of Bern around the mid-19th century. Master Thesis,* University of Bern, https://occrdata.unibe.ch/students/theses/msc/189.pdf (pdf, 2.5 MB).

Flückiger, J., A.-M. Burgdorf, Y. Brugnara, and S. Brönnimann (2020) Two meteorological series from Bern from Trechsel, 1826–1849, and Benoit, 1837–1853. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 97–108, doi: 10.4480/GB2020.G96.09.

Flückiger, S., S. Brönnimann A. Holzkämper, J. Fuhrer, D. Krämer, C. Pfister, and C. Rohr (2017) Simulating crop yield losses in Switzerland for historical and present Tambora climate scenarios. *Environ. Res. Lett.,* **12,** 074026, doi:10.1088/1748–9326/aa7246.

Frank D., U. Büntgen, R. Böhm, M. Maugeri, and J. Esper (2007) Warmer early instrumental measurements versuscolder reconstructed temperatures: shooting at a moving target. *Quat. Sci. Rev.,* **26,** 3298–3310.

Füllemann, C., M. Begert, M. Croci-Maspoli, and S. Brönnimann (2011) Digitalisieren und Homogenisieren von historischen Klimadaten des Swiss NBCN – Resultate aus DigiHom. *Arbeitsb. MeteoSchweiz* **236**, 48 pp.

Gisler, O. (1984) *Die meteorologischen Beobachtungen von Schaffhausen (1794–1845) und Zürich (1767–1802) nebst einigen Betrachtungen über historische Niederschlagsreihen.* Dissertation, Univ. Zurich.

Glaser, R. and H. Stangl (2004) Climate and floods in Central Europe since AD 1000: Data, methods, results and consequences. *Surv. Geophys.,* **25,** 485–510.

Grimmer, M. (2019) *The Meteorological Diaries of Johann Rudolf von Salis-Marschlins, 1781–1800*. Master thesis, Univ. Bern, https://occrdata.unibe.ch/students/theses/msc/283.pdf.

Häderli, S., S. Pfister, L. Villiger, Y. Brugnara, and S. Brönnimann (2020) Two meteorological series from Geneva, 1782–1791. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 33–46, doi: 10.4480/GB2020.G96.03.

Hupfer, F. (2015) Das Wetter in Tabellen. Christian Gregor Brügger und die Institutionalisierung der Meteorologie. In: Kupper, P., and B. C. Schär (Eds.) *Die Naturforschenden. Auf der Suche nach Wissen über die Schweiz und die Welt, 1800–2015*. hier + jetzt, Baden, p. 51–67.

Hupfer, F. (2019) Das *Wetter der Nation. Meteorologie, Klimatologie und der schweizerische Bundesstaat, 1860–1914.* Chronos Verlag, Zürich. 380 pp.

Hürzeler A., Y. Brugnara, and S. Brönnimann (2020) The meteorological record from St. Gall, 1812–1853. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 87–95, doi: 10.4480/GB2020.G96.07

Jacobeit, J., R. Glaser, J. Luterbacher, and H. Wanner (2003) Links between flood events in central Europe since AD 1500 and large-scale atmospheric circulation modes. *Geophys. Res. Lett.,* **30,** 21-1–21-4.

Pfister, C. (1984) *Das Klima der Schweiz von 1525–1860 und seine Bedeutung in der Geschichte von Bevölkerung und Landwirtschaft.* Haupt Verlag, Bern.

Pfister, C. (1999) *Wetternachhersage. 500 Jahre Klimavariationen und Naturkatastrophen (1496–1995).* Haupt Verlag, Bern.

Pfister, C., C. Rohr, and A. Jover (2017) Euro-Climhist: eine Datenplattform der Universität Bern zur Witterungs-, Klima- und Katastrophengeschichte. *Wasser Energie Luft,* **109,** 45–48.

Pfister, L., F. Hupfer, Y. Brugnara, L. Munz, L. Villiger, L. Meyer, M. Schwander, F. A. Isotta, C. Rohr, and S. Brönnimann (2019a) Swiss Early Instrumental Meteorological Measurements. *Clim. Past,* **15,** 1345–1361.

Pfister, L., S. Brönnimann, M. Schwander, F. A. Isotta, P. Horton, and C. Rohr (2019b) Statistical reconstruction of daily precipitation and temperature fields in Switzerland back to 1864. *Clim. Past Disc.* https://doi.org/10.5194/cp-2019-124.

Rohr, C. (2013) Floods of the Upper Danube river and its tributaries and their impact on urban economies (c. 1350–1600): the examples of the towns of Krems/Stein and Wels (Austria). *Environment and History,* **19,** 133–148.

Schüepp, M. (1961) *Lufttemperatur.* Beiheft zu den Annalen der SMZ, Zürich.

Schwander, M., S. Brönnimann, G. Delaygue, M. Rohrer, R. Auchmann, and Y. Brugnara (2017) Reconstruction of Central European daily weather types back to 1763. *Int. J. Climatol*., **37,** 30–44.

Thorne P. W., W., R. J. Allan, L. Ashcroft, P. Brohan, R. J. H. Dunn, M. J. Menne, P. Pearce, J. Picas, K. M. Willett, M. Benoy, S. Brönnimann, P. O. Canziani, J. Coll, R. Crouthamel, G. P. Compo, D. Cuppett, M. Curley, C. Duffy, I. Gillespie, J. Guijarro, S. Jourdain, E. C. Kent, H. Kubota, T. P. Legg, Q. Li, J. Matsumoto, C. Murphy, N. A. Rayner, J. J. Rennie, E. Rustemeier, L. Slivinski, V. Slonosky, A. Squintu, B. Tinz, M. A. Valente, S. Walsh, X. L. Wang, N. Westcott, K. Wood, S. D. Woodruff, and S. J. Worley (2017) Towards an

integrated set of surface meteorological observations for climate science and applications. *B. Amer. Meteorol. Soc.,* **98,** 2689–2702.

Weber, J., Y. Brugnara, and S. Brönnimann (2020) Two meteorological series from Herisau, 1821–1844. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 73–85, doi: 10.4480/GB2020.G96.06.

Wilkinson, C., S. Brönnimann, S. Jourdain, E, Roucaute, R. Crouthamel & IEDRO Team, P. Brohan, A. Valente, Y. Brugnara, M. Brunet, and G. P. Compo (2019) *Best Practice Guidelines for Climate Data Rescue*, Copernicus Climate Change Service.